Technological innovation in dairy herd data management: Applications

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ABSTRACT
Family enterprises have as their main characteristic the management by their own family and in them, the family works directly, with or without the help of others. It can be said that family farming represents a social innovation and that, regardless of the size of the enterprise, it must be managed to remain sustainable. With this in mind, this chapter deals with a study that aimed to program a software for the technical and economic management of the dairy production system of family farms, so that their managers will have data for decision-making in the rural business, as well as the professionals of the rural extension can provide rural assistance. The first step of the research was based on the identification and characterization of the evolutionary profile of small family farms, to identifying the technical demands of dairy farming on these family farms. The second step was the development of the computerized app, which used open-source PHP (Hypertext Preprocessor) programming language and was stored on the internet. The application can be accessed at http://www.pmppa.com.br/gestor/, running on the Window platform. The final step was the application test with the researched family farm properties data. The computerized app consists of easy data entry and handling, accessed online, with tools for zootechnical control (nutritional, reproductive and sanitary management) and management (production cost). The result was a free computerized app that generates and provides information in a simple and practical way, providing the family farmer with resources for simple and complex decision making. The application was registered at INPI through the number 512018051699-8.

Keywords: Computerized App, Dairy Cattle, Production Costs.

1 INTRODUCTION

According to the Family Farming Law, to be classified as a family farm, an agricultural establishment must be small (up to four (4) fiscal modules); have half of the family labor force; the agricultural activity on the establishment must comprise at least half of the family income; and have strictly family management (Brasil, 2006).

From the data of the Agricultural Census 2017-2018, the latest survey conducted by the Brazilian Institute of Geography and Statistics (IBGE), it appears that 76.8% of the 5.073 million rural establishments in Brazil were characterized as belonging to family farming. Specifically, in the State of Rondonia, the importance of the participation of family farming in the economy and in society is even more expressive, since 81.3% of the 91,438 establishments were classified as belonging to family farming, which represents an average of 76.8% above the national average. In these rural establishments, those that are part of the livestock branch comprise 31% of the state's herd and, of this herd, the milk production activity stands out, with a participation of 88.1% (IBGE, 2017).

The determining characteristics of family farms involve heterogeneity in the adoption of technology at work, express restrictions of capital, land to work and low level of knowledge or formal education. According to a survey conducted with family farmers, the higher level of education is directly associated with greater interest and flexibility of the producer in the search for improvement, improvement courses, such as good practices, sanitary control, and quality of their products. According to the authors of the research, the use of various technologies in dairy production discriminated, by multivariate analysis, groups of rural producers from the family farming group in the municipality of Pimenta Bueno-RO.

According to Asbraer (2014), technical assistance and the professionals who perform it play a key role in intermediating the production of knowledge and agricultural production, because in an exchange of experiences, means are established to incorporate research from universities and research institutes into production systems.

Technical assistance, in this sense, would be a means by which new technologies can be inserted into family farming activities. For Castro (2015), the technical assistance offered by the State Companies for Technical Assistance and Rural Extension (EMATERs) is maintained by state governments, is a free extension activity and directed to family farmers. According to Novo (2012), the States' Emater is an example in which its technicians, guided by R&D and extension, work closely with the small family farm dairy farmer.

According to Rocha Júnior et al., (2019), it should be noted that rural extension and assistance to family producers is also offered by entities such as municipal, state, and federal agencies (e.g., municipal agricultural secretariats), and even private companies (benefactors who purchase the production or input sellers). The extensionists' work is extremely important because, besides the

technical advice, they have an educational responsibility with the objective of providing knowledge and, thus, helping the rural producer to register pertinent information to the farming activities in progress and, consequently, to make available to him assertive decisions in his productive process.

The evaluation of the recording of activities on a dairy farm refers to the analysis of these records. Proper analysis can be done when accurate and complete farm records are available. The evaluation process allows a manager or owner to make informed decisions based on actual farm performance. Therefore, establishing and using an effective record keeping system of ongoing operations, still assists in farm planning, informed decision making, and analysis of both production and financial records. Decision making can be greatly enhanced by analyzing both production and financial records and their impact on profitability (Nuthall, 2011). For Modesto da Silva et al., (2014) the inclusion of IT may not even be considered as the solution for the activity, but a fundamental tool in the management process.

The management of rural activities is characterized by the set of activities developed so that there is planning, organization, and control of the productive and financial system. It helps in decision making so that the producer can manage production efficiently, minimize costs, and achieve better financial results. According to Machado (2007), the rural environment is in tune with current technology, including the internet, and it is possible to observe the use of rural management software products, which are replacing and/or complementing the old documental forms of control (note books) and becoming a great ally for decision making within the property.

It should be noted that, in addition to general and traditional production unit management, software products are increasingly considered as a flexible tool for analysis and programming in a technological flow (Sorensen et al., 2008).

In this context, software programs represent a new and efficient tool for a rational and timely management of the different aspects that are involved in animal production. Due to the demands of rural assistance technicians and rural producers, new software is being developed for use in specific sectors of production, for example, animal reproduction, genetic improvement, health or nutrition, and those already in use are progressively updated and improved. Also, those inserted in the technological processes at a higher level should be considered, for the use of new technological processes, for example automated units such as milking parlors and animal handling sheds.

The rural producers of family agriculture, despite all the difficulties, are part of the new technological reality of the rural world and, given this situation, the objective of this work was to develop a tool (software) easy to use by producers and rural extensionists, that can be used on computers, notebooks or cell phones that have internet access. In the sequence, the objective is to validate the software, by uploading the information (data) obtained from the milk producing properties of family farming.

This book chapter provides information about a study on the development of software, its use and registration with the INPI. The resources used to develop the software, its application and the registration process were then described.

The research was considered qualitative and classified as a case study because it sought to analyze the data and establish an interpretation of the inextricable link between the object of study and its subjectivity (Gil, 1999). This method may or may not be conducted in the field, but must seek depth and detail since the boundaries between phenomena and contexts are not clearly defined. (Gil, 2002). The case study procedure is developed when the researcher has no specific interest in the case, to aid knowledge or in the redefinition of a given problem (Severino, 2007). In this study, data from family farms were used to validate the "Cow milk cost" software.

The research was developed in the municipality of Colorado do Oeste, RO. The municipality of Colorado do Oeste is located in the southern cone of Rondônia and is formed by the geographical coordinates 13º 07' 00" S latitude and 60º 32' 30" W longitude, at an altitude of 410 meters.

The research was conducted in partnership with the Autarchic Entity of Technical Assistance and Rural Extension of the State of Rondônia (EMATER), in the period from March 2017 to July 2019. It used information (productive and financial data) of the dairy activity of family farming properties located in lines 01, 5, 6, 176, Mini axis and Nova 1. The properties assisted by EMATER extension technicians record the information in a notebook called "family farm milk production management notebook", from which the information was collected to supply the software developed in this work.

The inspection of the "family farm milk production management notebook" of 105 family farm rural properties was carried out in order to select those that presented the regularity of records that could be used in the "Cow milk cost" software. Among these, 48 were already participating in a professional training program to implement the artificial insemination system as a tool for reproduction of dairy cows, and this project was called "Inseminar"; 17 properties were considered by EMATER extensionists as a reference in milk production activity.

An Excel® spreadsheet was used to organize the information, containing zootechnical indexes such as: monthly milk production (total milk delivered to the dairy), percentage of lactating cows (amount of lactating cows multiplied by 100 and divided by the total number of matrices in the herd), percentage of matrix disposal/year (number of cows sold in the year multiplied by 100 and divided by the total number of matrices in the herd), percentage of area destined to milk production (size of area used for production in hectares multiplied by 100 and divided by the total area of the property), average production/cow/day (daily milk production divided by the number of lactating cows) and monthly expenses (sum of all costs for the month). In this context, the calculation to arrive at the monthly production cost of a dairy farm, used in the software, was: Production cost=total expenses for the month (Reais)/total milk produced in the month (liters).

In the software development, the data contained in the zootechnical, productive and economic survey of the properties was used as a base. We chose to use the PHP programming language because it is a free interpreted language, a set of codes with which these programs are written, which despite not being a visual language is a script language, is characterized as open source, used for the development of web applications, having its code embedded within the HTML. PHP can run on both Windows and Linux platforms and has zero cost of deployment, i.e. it can be downloaded by any user (Barnabé, 2010).

The process for registering the software at the INPI was according to the online submission criteria. Initially, it was necessary to obtain the digital signature of the right holder. Afterwards, the INPI's portal (http://www.inpi.gov.br) was accessed to issue the "Union Collection Guide (GRU)". The login was performed, since the registration had already been done in the e-INPI system. To effect the registration, the user made the acceptance in the application term. To effect the registration, the user made the acceptance in the software term and also the desired service (Computer Program Registration Request - RPC 730). At the end, a number was generated, which was used to start the "Electronic Request". The GRU and the Declaration of Veracity were downloaded, and for the declaration document it was necessary to make the electronic petition in a specific page (https://gru.inpi.gov.br/peticionamentoeletronico/).

After informing the GRU number, the electronic petition form was uploaded to the address mentioned above. The first information filled in was that of the holders, with the data of nationality and physical qualification, and then the other authors were added. The program data were also reported in the sequential tab of these authors.

As for the program data, "Publication date", "Creation date" and "Language" were entered. The next step referred to the "Hash Summary". In the "Hash Summary" field, the type of hash algorithm was selected, thus generating the encryption of the source code. This means, in other words, the transformation into a digital hash summary of the computer program excerpts and other data that were deemed sufficient and relevant to identify it, and the custodial responsibility of this data with the right holder.

The submission of the summary hash information in the electronic e-RPC form at the time of registration ensures that the object has not changed over the time of this guard. This technical documentation is fundamental to characterize the originality of the computer program with the "Judiciary", when applicable. In order to prove the authorship of a computer program (software), it was necessary to present the protected object, such as the source code or parts of this code, in court. Thus, the Registration Certificate issued by the INPI confers legal security to the computer program owner's business.

2 RURAL FAMILY FARM PROPERTY PARTICIPATING IN THE RESEARCH

Of the total of 105 farms whose "family farm milk production management notebooks" were inspected, only 17 had information recorded, however, we could count on only one farm that presented all the notes in an adequate form that could be used in the validation of the "Cow milk cost" software (Figure 1). It was observed that, with the exception of 17 families who recorded their information with some frequency, the other families of the rural properties available for the study had difficulties in making the records due to cultural barriers and formal education to continue the process of entering the information (zootechnical indexes, expenses with inputs used in production, as well as revenues generated on the property) in the notebook and, consequently, in the management of milk production, started with the assistance of EMATER.

Martins et al., (2014) conducted research with 48 families of these family farms of the inseminate project in the municipality of Colorado do Oeste, in the period from March 2013 to August 2013, with the aim of systematizing guidelines for farmers to professionalize their rural activity. The authors observed that the performance was below the goal and the time they had been receiving support from public policies aimed at improving the activity of producing milk; they emphasized that there were still many barriers that could be overcome and many problems that could be improved. They concluded that the result of EMATER's technical assistance (lectures, courses, demonstrations of methods, meetings, field days and technical visits) directed at the families was not very satisfactory with regard to dairy management.

In general, farm record keeping is affected by the size of the farm, level of formal education of the owners, years of farming experience. According to Poggio (2006), illiteracy, lack of time, lack of incentive, and lack of awareness are frequent limitations faced by farmers in developing countries in keeping records of dairy production activity.

Figure 1. Rural properties of family farming in Colorado do Oeste - RO available for the validation of the software "Cow milk cost", with their information, in the period from March 2017 to August 2019. Inseminar project refers to a program aimed at specific assistance in the reproduction of dairy cows using artificial insemination. Reference properties (Prop Referenciais) were considered by EMATER technicians to be those with the best milk production performance.
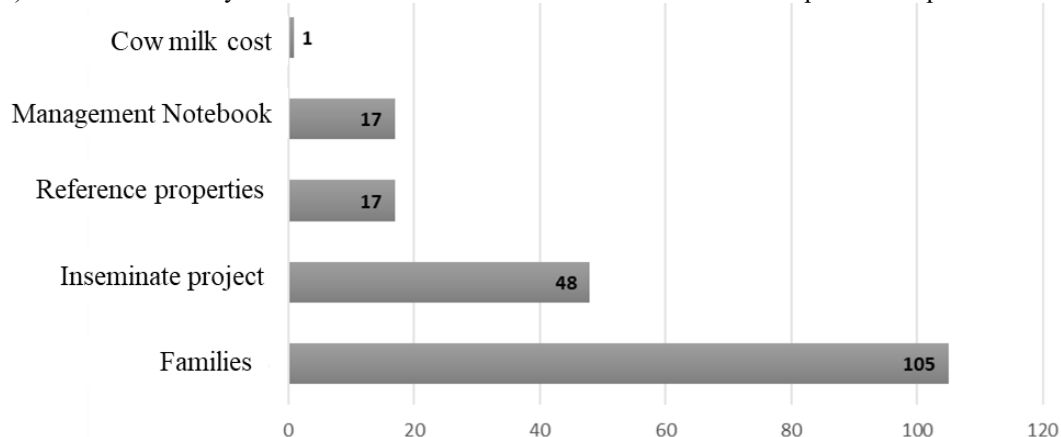
3 OPERATION AND VALIDATION OF THE "COW MILK COST" SOFTWARE

To start using the "Cow milk cost" software, one must access, on the login tab, the area to register in the system, filling in information such as password, e-mail address, and access IP. If the user is already registered, he/she enters the login and password (Login Screen) (Figure 2).

Figure 2. Access screen to enter/register in the "Cow Milk Cost" software.
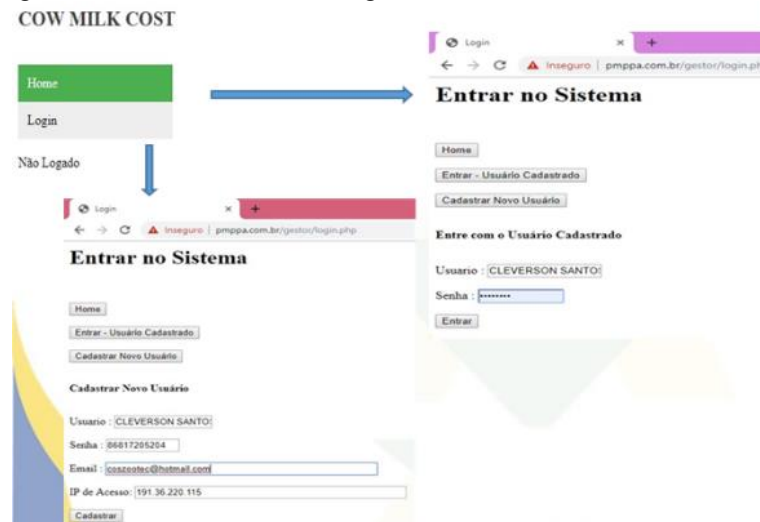
The main screen of the software contains the link to all existing functionalities, as follows: "Login" to access the tool's features; "Managed Property": area where the name, address, name of the producer, area of the property and pasture in hectare, and main activity are entered; "Daily Entry": area intended for the postings of daily milk production, expenses and revenues of the dairy activity; "Monthly Monitoring": is the area intended for monitoring the financial results of total milk produced, total revenue from milk sales, total revenues (involves sales of animals and other products of the dairy activity) and total expenses; "Annual Follow-up": it is the gathering of the financial results of all the months of the year (only for registration and visualization); "Evolution of the Herd": it monitors the movement of male and female animals in the phases from 0 (Zero) to 12 months, 13 to 24 months and 25 to 36 months within the property; "Reports": presents information of production, expenses and revenues as to dates, quantity, description of posted items, unit value and total value; "Cost of Milk": presents the survey, in a simplified way, the cost of production of 1 (One) liter of milk produced in each month of the year; "Weekly Quotes": an area destined for the insertion of values of inputs, milk price and other important products in dairy farming. Such values can be changed weekly, according to the price changes in the region.

After registering, should the need arise, the user can change any of the data posted by clicking on "Alter property data".

To enter information, there is the "Journal Entry" area, which is subdivided into: herd entry, milk production entry, expense entry, and revenue entry. These tools correspond to the zootechnical

control and financial management of all daily decision-making in dairy farming within the production system. Here the field information that will compose the entire production cost of the liter of milk produced is entered.

Regarding information about the herd, the access area "Herd Entry" is used to enter data about the young animals that are entering the property's herd on a certain date. The herd to be entered goes through 3 (three) animal category phases, being they calves (suckling calves and heifers), rearing (yearling calves and heifers), and animals of reproductive age (bullocks and heifers).

The "Production Entry" area is the place used to enter the daily information regarding the amount of milk sold, the average value of the liter of milk sold, and information about lactating and discarded matrices on a certain date. It was also provided a place to enter revenues from the sale of animals and other dairy products. The values are entered based on the sales invoices.

The site used for entering data on expenses was called "Expense Entry" and comprises the expenses incurred during the month in dairy farming (fixed and variable costs inherent to production; amounts in Reais (R$)).

For the monthly follow-up of the dairy activity, the financial overview of the dairy activity was made available through the total liters of milk produced, total revenue from milk sales, total revenues and total expenses, by means of a report. For the annual follow-up, the user can search the history of results (cash flow) for all months of the year, being able to store data from several years of activity, so that he can refer to the previous year to plan for the following year.

The availability of information for direct use is indispensable for the rural producer to make priority decisions. According to Asemi; Safári; Zavareh (2011), an Agricultural/Livestock Management Information System (APIS) is a management information system (MIS) that is used in the industry, being a software system to organize and provide past, present, and projected information. Information includes both the internal workings of the organization and its interaction with the external world.

In the present study, in the development of the software "Cow Milk Cost", a place was provided for the user to have access to the list of all the entries of "Production" (information about the existing herd in the period (heifers, bullocks, heifers, calves, lactating cows and discarded cows), the quantity of liters produced, the value of the liter of milk, and the total value of the sale of milk), "Expenses and Revenues", being able to search on any date that is more convenient or of interest to the milk producer.

For Tummers et al. (2019), a management system is used to collect, process, store and disseminate information to carry out operations in the business as it provides the data in an informative way to the producer, who is able to make better decisions using the system as it provides better insights that he would not have without its use.

Kassahun et al (2022), conducted a survey study of information on the use of management systems used on dairy farms in the Netherlands. The authors combined the use of an online survey

questionnaire with literature review and identified the different types of data managed by the different types of systems which included fertility values, cow activity, rumination activity, concentrate feed intake, calving dates, milk production, milk quality attributes (fat percentage, protein percentage, cell count, conductivity), fertilizer use, field location, field area, bull characteristics, feed consumption and cash flow. According to the survey, the authors identified the main advantages of using management systems, as mentioned by the Dutch dairy farmers interviewed (1. it provides easy and clear access to useful data; 2. system runs 24/7; it can provide data at any time; 3. offers a way to react quickly to certain situations; 4. data is easy to export to other systems) and, the disadvantages (1. current systems or extra options are too expensive; 2. offers an unclear display of data; 3. does not contain useful overviews that the farmer wants to see).

In Brazil, Zimpel et al. (2017) observed, in the study conducted with 55 questionnaires answered by rural producers (milk) in the western region of Paraná, that in general, producers do not adopt practices or tools in the financial management of their businesses. Those that do, represent small dairy properties, with lower production, managed by younger producers and employing younger workers, reflecting the most modern management model, unlike the older management models practiced by more experienced farmers. According to the authors, even though they use and record costs in spreadsheets and financial management software, they do not necessarily make adequate use of the information for decision-making.

4 REGISTRATION OF THE SOFTWARE BY THE INPI AND AVAILABILITY FOR ITS USE

The software registration was granted by the INPI after the application process (BR 51 2018 051699 8), on 09/17/2018 and, the act was published in the "Revista Eletrônica da Propriedade Industrial (RPI)", which is the place for the publication of acts, dispatches and decisions related to the activities of the Autarchy (INPI). The act of the software "Cow Milk Cost" is on RPI number 2490.

The "Cow Milk Cost" program is available for free and can be accessed from smarthphones, tablets, notebooks and computers that are connected to the internet (on line version only), and is inserted in the site of the Professional Master in Animal Production Program <www.pmppa.com.br>, and can be accessed through the link http://www.pmppa.com.br/gestor/index.php.

It was concluded that it is possible to develop a user-friendly computer program (software) that can be accessed on computers, notebooks or cell phones that have internet access, along with the dissemination and validation of the information (data) obtained from rural properties.

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